Appendix G: RCI, and Waste - detailed policy description/analysis

Overview

The Residential, Commercial and Industrial (RCI) sector includes emissions and mitigation opportunities related to electricity use by residential, commercial, and industrial consumers, as well as to the on-site combustion of natural gas, oil, and coal, the release of CO_2 and fluorinated gases (HFCs, PFCs) during industrial processes, and the leakage of HFCs from refrigeration and related equipment. The CCAG recommends a set of 13 policy options for the RCI sector that offer the potential for major GHG emissions reductions from the reference projection. As summarized in the table below, these 13 policy recommendations could lead to net emissions savings from reference case projections of 31.1 $MMtCO_2e$ per year by 2020 and cumulative savings of 222 $MMtCO_2e$ from 2007 through 2020. The weighted average cost of saved carbon from the policy options for which quantitative estimates of both costs and savings were prepared was minus $30 per metric ton of CO_2 equivalent, meaning that there is a net savings to the Arizona economy in implementing these options.

For each recommended RCI policy, this technical appendix provides details on design, analysis, quantification of impacts, and other related information. (See Appendix E for explanation of the general methods applied across all groups). When these RCI policies were quantified, some policies were considered to have overlapping impact. To avoid double-counting of GHG emission reductions, the following steps were taken to arrive at the estimates of "overlaps" between policies that are reported in the last of the three tables shown below ("Adjustment for Estimated Overlap Between RCI Options"):

- RCI-2, State Lead by Example, has two elements, building (not appliance) energy efficiency improvements, and green power purchasing. If state agencies are eligible for RCI-1 programs, then there may be some overlap between RCI-2 and RCI-1. The Estimated overlap shown below in the table below assumes 50% overlap with RCI-1 from RCI-2 energy efficiency improvements.
- RCI-3 has no overlap with RCI-1, since savings from appliance efficiency in RCI-1 would be over and above standards.
- RCI-4, building standards for Smart Growth, would have no overlap with RCI-1, as RCI-1 would be over and above standards. RCI-4 would also have no significant overlap with RCI-2, as RCI-2 would provide savings beyond codes.
- RCI-5, "Beyond Code" Building Design Incentives and Programs for Smart Growth may have some overlap with RCI-1, and also with RCI-2, although RCI-5 is focused on building energy measures. This overlap is estimated roughly at one-third, or 33% of total RCI-5 savings.
- RCI-6, Distributed Generation/Combined Heat and Power, has no significant overlap with other RCI policies (note that the estimate of RCI-2 impacts does not quantify the contribution of CHP to RCI-2 savings).
- RCI-7, Distributed Generation/Renewable Energy Applications, has no significant overlap with other RCI policies.
- RCI-8, Electricity Pricing Strategies, may have some overlap with RCI-1 to the extent that higher upper-tier tariffs induce consumers to take advantage of DSM programs in greater numbers, but DSM programs are not allowed to expand to meet demand. On the other

hand, however, stronger market forces might allow DSM programs to operate with lower incentives, yielding higher savings per dollar of program cost and allowing more consumers to be served by DSM programs. It is assumed that 50% of estimated savings in RCI-8 is due to conservation (not energy efficiency improvement) as a result of higher-tier tariffs, and that thus only the other 50% of RCI-8 savings is subject to an overlap of 50% maximum with RCI-1, yielding the overlap shown in the table below.

- RCI-10, Demand-Side Fuel Switching, may overlap with RCI-1 to the extent that Solar Water Heat (SWH) is included in RCI-1. Overlap of RCI-10 with RCI-1 is calculated assuming an overlap of 50% of SWH savings would yield the overlap shown above.
- In RCI-12, quantitative estimates of impacts focus mostly on reduction in manufacturing energy and materials requirements due to reductions in materials requirements resulting from mixed paper recycling. As most of Arizona's paper comes from outside Arizona, overlap of RCI-12 with industrial efficiency measures in RCI-1 or with other RCI options will be very small, thus no overlap is assumed.
- In RCI-13 Water Use and Wastewater Management, pump efficiency improvement elements of RCI-13 would likely overlap to a degree with the industrial (and other sector) electric motor and drives savings in RCI-1. As the quantification of RCI-13 focuses on the reduction of water use, rather than pumping efficiency improvements, it is assumed that RCI-13 has no significant overlap with RCI-1.

Additional Detail on the Analyses of Options Benefits and Costs for Policies Described Below

The "Policy Descriptions" provided below (starting on page G-6 of this Appendix) for each of the 13 RCI Mitigation Policy Options recommended by the CCAG include brief summaries, if applicable, of the methods and data used to estimate the emissions reduction potential, costs, and/or other benefits of the Options. Additional details of the estimates of costs and benefits of Policy options, including notes on assumptions and data used, and intermediate results, can be found in the document Residential Commercial and Industrial Technical Working Group: Detailed Description of Data Sources, Methods, and Assumptions for Analysis of Policy Options, which can be accessed through the "Residential, Commercial, and Industrial TWG" section of the http://www.azclimatechange.us/documents.cfm web page.

Residential, Commercial and Industrial Technical Work Group
Summary List of Policy Options

#	Policy Name	GHG Savings ($MMtCO_2e$)	Cost-Effectiveness ($/t$CO_2e$)	Level of CCAG Support
RCI-1	Demand-Side Efficiency Goals, Funds, Incentives, and Programs	2010: 3.1 2020: 15.1	- $36	Unanimous
RCI-2	State Leadership Programs	2010: 0.04 2020: 0.4	- $4	Unanimous
RCI-3	Appliance Standards	2010: 0.2 2020: 1.0	- $66	Unanimous
RCI-4	Building Standards/Codes for Smart Growth	2010: 0.3 2020: 2.2	- $18	Unanimous
RCI-5	"Beyond Code" Building Design Incentives and Programs for Smart Growth	2010: 0.2 2020: 3.1	- $17	Unanimous
RCI-6	Distributed Generation/Combined Heat and Power	2010: 0.4 2020: 2.7	- $25	Unanimous
RCI-7	Distributed Generation/Renewable Energy Applications	2010: 0.1 2020: 2.1	$31	Unanimous
RCI-8	Electricity Pricing Strategies	2010: 1.1 2020: 1.5	-$63	Unanimous
RCI-9	Mitigating High Global Warming Potential (GWP) Gas Emissions (HFC, PFC)	Not Quantified		Unanimous
RCI-10	Demand-Side Fuel Switching	2010: 0.1 2020: 1.2	Not estimated	Unanimous
RCI-11	Industrial Sector GHG Emissions Trading or Commitments	See ES-4	See ES-4	Unanimous
RCI-12	Solid Waste Management	2010: 2.2 2020: 3.7	Not estimated	Unanimous
RCI-13	Water Use and Wastewater Management	2010: 0.2 2020: 0.8	Not estimated	Unanimous

Summary Results and Totals for RCI Policy Options

	Policy Name	GHG Reductions ($MMtCO_2e$) 2010	GHG Reductions ($MMtCO_2e$) 2020	Cost-Eff ($/$tCO_2e$)	NPV 2006-2020 ($million)	Cumulative Emissions Reductions ($MMt CO_2e$, 2006-2020)
RCI-1	Efficiency Goals, Funds, Incentives, and Programs	3.1	15.1	-$36	-$3,671	103
RCI-2	State Leadership Programs	0.04	0.4	-$4	-$12	3
RCI-3	Appliance Standards	0.2	1.0	-$66	-$453	7
RCI-4	Building Standards/Codes for Smart Growth	0.3	2.2	-$18	-$243	14
RCI-5	"Beyond Code" Building Design for Smart Growth	0.2	3.1	-$17	-$59	18
RCI-6	DG/Combined Heat and Power	0.4	2.7	-$25	-$395	16
RCI-7	DG/Renewable Energy Applications	0.1	2.1	$31	$293	10
RCI-8	Electricity Pricing Strategies	1.1	1.5	-$63	-$985	16
RCI-9	Mitigating High (GWP) Gas Emissions	*Not Quantified*				
RCI-10	Demand-Side Fuel Switching	0.1	1.2	*Not Estimated*		7
RCI-11	Industrial Sector GHG Emissions Trading	*Not Quantified*				
RCI-12	Solid Waste Management	2.2	3.7	*Not Estimated*		36
RCI-13	Water Use and Wastewater Management	0.2	0.8	*Not Estimated*		6
	Total Gross Savings	**7.9**	**32.9**	**-$30**	**-$5,525**	**236**

Adjustment for Estimated Overlap Between RCI Options	GHG Reductions ($MMtCO_2e$) 2010	GHG Reductions ($MMtCO_2e$) 2020	NPV 2006-2020 ($million)	Cumulative Emissions Reductions ($MMt CO_2e$, 2006-2020)
RCI-2 Overlap with RCI-1	0.0	0.1	-$4	1
RCI-3, Overlap with RCI-1	0.0	0.0	$0	0
RCI-4, Overlap with RCI-1 and RCI-2	0.0	0.0	$0	0
RCI-5, Overlap with RCI-1 and RCI-2	0.1	1.0	-$19	6
RCI-6 Overlap with Other Quantified Policies	0.0	0.0	$0	0
RCI-7 Overlap with Other Quantified Policies	0.0	0.0	$0	0
RCI-8 Overlap with RCI-1	0.3	0.4	-$246	4
RCI-10 Overlap with RCI-1	0.0	0.4	$0	2
RCI-12, -13 Overlap with RCI-1	0.0	0.0	$0	0
Total Estimated Overlap Among RCI Policies	0.4	1.9	-$269	13
Total Savings Net of Overlaps	7.5	31.1	-$5,255	222

The energy savings (measured in GWh of electricity, Billion BTU of natural gas, and Billion BTU of other fuels, and measured in dollars) associated with RCI policy recommendations are presented in the table below.

ENERGY SAVINGS FROM RCI OPTIONS

		NPV 2006-2020, million 2005 dollars)											
		Estimated Fuel Cost (negative values denote net savings)						2020			Cumulative Fuel Savings (2006 - 2020)		
	Policy Name	Electricity	Natural Gas	Other Fuels	Total	Incremental Non-fuel Costs of Option	Net Cost of Option	Electricity (GWh)	Natural Gas (Billion Btu)	Other Fuels (Billion Btu)	Electricity (GWh)	Natural Gas (Billion Btu)	Other Fuels (Billion Btu)
RCI-1	Efficiency Goals, Funds, Incentives, and Programs	($5,436)	($70)	$0	($5,506)	$1,835	($3,671)	19,339	4,388	-	136,444	14,930	-
RCI-2	State Leadership Programs	($80)	($8)	$0	($88)	$80	($8)	335	0	-	2,050	1,623	-
RCI-3	Appliance Standards	($405)	($8)	$0	($413)	($41)	($453)	1,234	261	-	8,949	1,306	-
RCI-4	Building Standards/Codes for Smart Growth	($594)	($47)	$0	($641)	$398	($243)	2,696	1,852	-	17,342	9,185	-
RCI-5	"Beyond Code" Building Design for Smart Growth	($492)	($40)	$0	($532)	$492	($40)	2,560	1,902	-	15,512	7,949	-
RCI-6	DG/Combined Heat and Power	($1,164)	$603	($2)	($563)	$169	($395)	4,585	-21,445	(4,429)	25,999	(132,169)	(23,502)
RCI-7	DG/Renewable Energy Applications	($495)	$0	$0	($495)	$788	$293	2,440	-	(4,664)	11,490	-	(26,739)
RCI-8	Electricity Pricing Strategies	($738)	$0	$0	($738)	$0	($738)	1,313	-	-	14,086	-	-
RCI-9	Mitigating High (GWP) Gas Emissions				*Not Quantified*								
RCI-10	Demand-Side Fuel Switching												
RCI-11	Industrial Sector GHG Emissions Trading				*Not Quantified*								
RCI-12	Solid Waste Management				*Not Quantified in Terms of Fuel Savings*								
RCI-13	Water Use and Wastewater Management				*Not Quantified in Terms of Fuel Savings*								
SUM OF QUANTIFIED VALUES		($9,405)	$430	($2)	($8,977)	$3,721	($5,255)	34,502	(13,043)	(9,093)	231,872	(97,176)	(50,241)

RCI-1 Demand-Side Efficiency Goals, Funds, Incentives, and Programs

Policy Description:

This policy option considers energy savings goals for electricity and natural gas, and the policy, program, and funding mechanisms that might be used to achieve these goals. These are intended to work in tandem with other strategies under consideration by the RCI and ES TWGs.

Policy Design:

This option contains three principal elements – goals, funding and implementation mechanisms, and planning -- along with several supporting activities, as described below.

Goals: Suggested energy savings goals are as follows:

- Electricity (energy savings target): 5% savings by 2010, 15% savings by 2020. These savings targets would be for electricity sales (MWh), and would reflect cumulative (from today), verified savings as a percentage of those years' (projected) loads, starting from the time of policy adoption.
- Natural Gas (utility spending target): ramp up to spending 1.5% of gas utility revenues by 2015.[1] Further decisions by the ACC to decouple gas sales and revenues are viewed as central to achieving this target[2].

Implementation Mechanisms:

Several policy options are commonly used to overcome market, administrative, and institutional barriers to cost-effective efficiency improvements. These options can include public benefit charges, tariff riders, enabling legislation, and/or regulatory directives. They can also work together with state and national tax incentives for energy efficient equipment. Indeed, an evolving and flexible mix of these policy mechanisms may be needed to achieve the efficiency goals described here.

Incorporation of Efficiency in a Planning Context: Inclusion of energy efficiency resource in an integrated resource planning (IRP) process can enable the overall most efficient and cost-effective delivery of energy services. IRP is currently practiced in Arizona, and is under consideration by the ES TWG.

In addition, supporting activities may be important elements in the success of energy efficiency strategies. These supporting strategies could include consumer education and outreach programs (including, for example, enhanced State Energy Office and University-

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[1] These targets would apply to all utilities in the state. Electricity and natural gas goals are deliberately expressed in different metrics -- energy savings and revenue targets, respectively – due to recognized differences in experience with efficiency programs with each fuel. Experience with electricity efficiency is sufficient to enable targets to be established, as has been done in several states (such as CA and TX). Experience with natural gas efficiency programs is more limited, thus it may be premature to establish energy savings goals.

[2] CCAG members expressed a desire to ensure that these targets are adequately ambitious, and thus to revisit these targets once initial analysis is complete.

based energy-efficiency extension services), and market transformation programs and organizations. Supporting strategies will be considered as part of overall recommendations, but their impacts will not be quantified. They could also include decoupling utility sales and revenues and creating performance incentives that reward utilities for implementing effective DSM programs.

Related Policies/Programs in Place:

- The ACC recently approved DSM funding by Southwest Gas (SW Gas) at a level of 0.8% of revenues.
- Arizona utilities (including APS, SRP, TEP and SW Gas) operate a number of DSM programs, including audits, new home programs, shade tree programs, appliance rebates, and others. In addition, the Arizona Department of Commerce's Energy Office provides energy efficiency programs for businesses, communities and homeowners in Arizona.
- In 2004, the Arizona Corporation Commission (ACC) issued a recommended order in a recent Arizona Public Service Co. rate case, supporting a funding level of $16 million per year for APS demand-side management (DSM) programs, an increase from $1 million per year.
- In 2002, Tucson Electric Power was approved to spend $1 million of System Benefits Charge funding for low income and energy efficiency programs
- Arizona home sellers can subtract 5% (up to $5,000) of the sales price of a single family home or condominium that is 50% more efficient than the 1995 Model Energy Code (MEC) from their income for the purpose of calculating their state income tax. The income tax deduction is available through 2010.

Types(s) of GHG Benefit(s):

The principle benefit is the reduction in GHG emissions (largely CO_2) from avoided electricity production and avoided on-site fuel combustion. Less significant benefits are the reduction in CH_4 emissions from avoided fuel combustion and avoided pipeline leakage. Other GHG impacts are also conceivable, but are likely to be small (black carbon, N_2O) and/or very difficult to estimate (materials use, life cycle, market leakage, etc.).

Estimated GHG Savings and Costs per tCO_2e:

RCI-1	2010	2020	Units
GHG Emission Savings	3.1	15.1	$MMtCO_2e$
Net Present Value (2006-2020)		-$3,671	$ million
Cumulative Emissions Reductions (2006-2020)		103	$MMtCO_2e$
Cost-Effectiveness		-$36	$/$tCO_2e$

Other Key Results (RCI-1)	2010	2020	Units
Fraction of Electric Utility Revenues spent on efficiency	2.6%	2.5%	
Equivalent Public Benefit Charge (electricity)	1.9	1.8	$/MWh
Electricity Savings (including recent actions)	4,208	18,400	GWh (sales)
Natural Gas Savings (including recent actions)	1,719	10,890	Billion BTU

Recent Actions (current/planned efficiency spending levels) not included in forecast (GHG Emissions Savings not included above)	2010	2020	Units
Electricity	0.3	0.9	$MMtCO_2e$
Natural Gas	0.1	0.3	$MMtCO_2e$
Total	0.4	1.3	$MMtCO_2e$

Discussion: Savings from recent actions reflects the emissions reductions that are likely to accrue from current and planned statewide spending levels on energy efficiency ($12 million/year for electricity; 0.8% of SW Gas natural gas revenues for natural gas). The impact of additional effort in RCI-1 reflects the added statewide economic savings (nearly $4 billion, NPV through 2020) and emissions reductions that would accrue from the statewide goals in this policy measure over and above the current and planned statewide spending levels. The negative cost-effectiveness and NPV reflect a *net benefit* statewide.

The fraction of electric utility revenues spent on efficiency averages about 2.5%. This level of spending is similar to that maintained by utilities in the Pacific Northwest in the 1990s. If this level of spending were translated into a public benefit charge, it would require a public benefit charge on the order of about $2/MWh (0.2 cents or 2 mills per kWh).

Data Sources, Methods, and Assumptions:

See the document referenced on page G-3 of this Appendix for a more detailed listing of methods, data sources, and assumptions used in this analysis. In summary:

- Data Sources: Key data sources include US DOE Energy Information Agency (historical and projected prices, SW Gas market share), WGA CDEAC EE Task Force, Northwest Power Council, and California Energy Commission (costs of efficiency programs), SW Energy Efficiency Project (current level of electricity efficiency spending.)
- Quantification Methods: The estimation of electricity and natural gas savings (MWh and million Btu) is relatively straightforward. For electricity, savings are simply the goal times that years' projected loads. For natural gas, projected gas revenues are estimated (based on projected prices and sales), then multiplied by the goal (1.5%) and by the assumed savings per program dollar spent (below). GHG savings are estimated based on marginal emissions rates for electricity (0.7 to 0.8 tCO_2e/MWh – See the document referenced on page G-3 of this Appendix for a more detailed listing of methods, data sources, and assumptions used in this analysis) and on standard emission rates for natural gas (see inventory). Cost analysis is based on the differential between avoided costs and the levelized cost of efficiency savings.
- Key Assumptions: Key assumptions include avoided electricity and gas costs (levelized prices used as a proxy), levelized total costs of efficiency programs ($25/MWh, $2.1/MMBtu), and program spending requirements (6 MWh/yr per $1000 spent, 75 MMBtu/yr per $1000 spent). Another key assumption is that the savings goals apply to all electric and gas utilities in the state.

Key Uncertainties:

- Avoided electricity and natural gas costs.
- Costs and availability of efficiency resources.

Ancillary Benefits and Costs:

These include (source: WGA CDEAC, 2005)

- Saving consumers and businesses money on their energy bills;
- Reducing dependence on imported fuel sources;
- Reducing vulnerability to energy price spikes;
- Reducing peak demand and improving the utilization of the electricity system;
- Reducing the risk of power shortages;
- Supporting local businesses and stimulating economic development;
- Enabling avoidance of the most controversial energy supply projects;
- Reducing water consumption by power plants; and
- Reducing non-GHG pollutant emissions by power plants and improving public health.

Feasibility Issues:

None cited.

Status of Group Approval:

Completed.

Level of Group Support:

Unanimous.

Barriers to Consensus:

None cited.

RCI-2 State Leadership Programs

Policy Description:

Government-led, or "Lead by Example", initiatives help state and local governments achieve substantial energy cost savings while promoting the adoption of clean energy technologies by the public and private sectors.

Policy Design:

The policy actions under consideration include:

- Extension of state building energy savings goals (Statute A.R.S. 34-45) to include a further 15% reduction in energy use per square foot in state buildings from 2011 to 2020, along with purchasing EnergyStar equipment.
- Standards for new state buildings, with possible design parameters including recommendations that new state buildings be more energy-efficient than current building codes require, or to adopt LEED[3]-related requirements, such as those recommended by the Arizona Working Group on Renewable Energy and Energy Efficiency and by the WGA CDEAC EE[4] Task Force (See also Option RCI-5), as well as mechanisms to support the state in achieving its goals.
- Green Procurement Strategies, such as installation of renewable energy systems for additional backup in emergency services buildings (e.g., police stations, fire stations, National Guard facilities), and efforts to promote or require the purchase by state buildings of 5% of their building energy needs from renewable sources (over a phased-in period) by 2012, increasing to 10% by 2020[5].
- The promotion of new combined heat and power (CHP) facilities in State Buildings, such as the facilities in place and under construction at Arizona State University and the University of Arizona (approximately 35 MW total), and the expansion of existing performance contracting law to require life cycle analysis for CHP in State lease-purchase construction.

The TWG suggests that the State Energy Office add staff capability and responsibility for a) ensuring effective compliance with state procurement and savings goals, and b) sharing and communicating the state's accomplishments and lessons learned (by, for example, assuming a "cooperative extension" role). Furthermore, the state should consider adopting procurement guidance, such as that included in the Energy Policy Act of 2005. A number of

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[3] Leadership in Energy and Environmental Design, a "...voluntary, consensus-based national standard for developing high-performance, sustainable buildings.". See http://www.usgbc.org/.

[4] Energy Efficiency Task Force Report to the Clean and Diversified Energy Advisory Committee of the Western Governors' Association.

[5] CCAG members suggested that the State revisit the green purchase target to ensure that it is adequately ambitious, and to ensure that the state leadership targets, in general, could not be circumvented through outsourcing (i.e., that the targets be applicable to private entities working as contractors to the State). Additional policy description text provided below includes a number of additional components including the state ombudsman role noted during the CCAG meeting.

additional elements of State Leadership programs should be considered as well, as noted at the end of this option.

Additional Recommendations for State Leadership Programs: The following are based on findings of the WGA CDEAC EE Task Force and AZ EE/RE Working Group[6].

- With respect to the LEED green building standards, the State should investigate the feasibility of requiring additional commissioning as well as measurement and verification to ensure that they are meeting the energy savings targets noted above.
- The State should construct new buildings that serve as examples of energy-efficiency by surpassing minimum energy code requirements by a wide margin.
- The Governor should use public events, such as installing energy efficiency products in the Governor's residence, or openings of new energy efficient projects, or public awards (energy efficiency or renewable energy awards) to draw attention to the State's renewable energy and energy efficiency ethic.
- The Governor and state agencies should promote the use of State and other public facilities as demonstrations of energy efficiency and renewable energy.
- The State should provide financial and technical assistance for implementation of energy savings projects in existing buildings and facilities.
- The State should use energy service companies (ESCOs) and performance contracting to implement efficiency projects without public sector capital investment.
- The Governor and the Department of Administration should establish a program to install renewable energy systems as additional backup services in emergency services buildings
- The Governor should require state buildings – including schools – to purchase, install and operate cost-effective renewable energy equipment or purchase green power to meet 5% of their building energy needs over a phased-in period by 2012.
- The Governor and State agencies should require State offices to buy a percentage of their electricity from renewable resources, if cost-effective.
- Current state law (ARS 34-355) allows the use of cogeneration (combined heat and power) in performance contracting. This law should be expanded to require life cycle analysis for CHP in State lease-purchase construction.
- HB 2430 expands the use of CHP for State facilities and schools. This bill (if ultimately adopted) should be built upon in the future.[7]

Implementation Method(s):

[6] As expressed in the Energy Efficiency Task Force Report to the Clean and Diversified Energy Advisory Committee of the Western Governors' Association, The Potential for More Efficient Electricity Use in the Western United States, December 19, 2005. This report is referred to elsewhere in this Appendix as the "WGA CDEAC EE report" and can be found at: http://www.westgov.org/wga/initiatives/cdeac/Energy%20Efficiency.htm. A companion WGA CDEAC report, the Combined Heat and Power White Paper, dated January, 2006, is also quite germane to the some of the policy options that follow, as is the Solar Task Force Report, also dated January, 2006.

[7] See http://www.azleg.state.az.us/FormatDocument.asp?inDoc=/legtext/47leg/2r/summary/h.hb2430_02-24-06_asengrossedandaspassedhouse.doc.htm.

These could include, among others, funding mechanisms and incentives, legislation/statutes, codes and standards, and reporting.

Related Policies/Programs in Place:

- Statute A.R.S. 34-451 directs state agencies and universities to achieve a 10% reduction in energy use per unit of floor area by 2008, and a 15% reduction by 2011; purchase cost-effective ENERGY STAR or Federal Energy Management Program-designated energy-efficient products; and meet energy conservation standards developed by the Arizona Department of Commerce's Energy Office.
- HB 2501 "Schools: Energy Efficiency Funds", if adopted, will promote the establishment of energy efficiency funds by schools, with monies deposited by utilities. The funds will be used to purchase energy-efficiency products and services. Schools use utility bill savings to repay the capital cost of energy efficiency measures (see http://www.azleg.state.az.us/FormatDocument.asp?inDoc=/legtext/47leg/2r/summary/h.hb2501_02-15-06_caucuscow.doc.htm).
- Executive Order 2005-05 implementing renewable energy and energy efficiency in new state buildings (http://www.governor.state.az.us/eo/2005_05.pdf)
- A May 2001 Executive Order directed state agencies and employees to implement energy conservation measures in state facilities.

Types(s) of GHG Benefit(s):

To the extent state actions are focused on reducing electricity and natural gas purchases or increasing renewable energy production, GHG impacts are likely to be similar to those described for RCI-1 above.

Estimated GHG Savings and Costs per tCO_2e:

RCI-2	2010	2020	Units
GHG Emission Savings	0.04	0.4	$MMtCO_2e$
Net Present Value (2006-2020)		-$12	$ million
Cumulative Emissions Reductions (2006-2020)		4	$MMtCO_2e$
Cost-Effectiveness		-$3	$/$tCO_2e$

Other Key Results (RCI-2)	2010	2020	Units
Green Power Purchased	45	183	GWh (sales)
GHG Emission Savings from Green Power Purchasing	0.04	0.2	$MMtCO_2e$
GHG Emission Savings from Extending Building Savings Goals	0.00	0.2	$MMtCO_2e$

Recent Actions not included in forecast (GHG Emissions Savings not included above)	2010	2020	Units
Current state building savings goals	0.16	0.28	$MMtCO_2e$
Recent CHP installations	0.12	0.12	$MMtCO_2e$
Total	0.28	0.39	$MMtCO_2e$

Discussion of Results: Savings from recent actions reflect the emissions reductions that are likely to accrue from current state building savings goals and the combined heat and power installations recently installed or coming on line at Arizona universities. Two elements of this policy option are readily quantifiable: extending and deepening the state building energy savings goals from 2011 onward, and green power purchasing. The benefits of promoting CHP at state buildings are incorporated in the overall assessment of commercial CHP potential (see policy RCI-6), and are not reported separately here. Similarly, the benefits of standards for new state buildings are not estimated separately here, but are incorporated in the analysis of new building strategies below (see policies RCI-4 and RCI-5).

The negative cost-effectiveness and NPV reflect an overall net benefit statewide. The cost savings of the extended state buildings goals ($18 million, NPV) more than offsets the net costs of the green power purchasing efforts ($5 million, NPV).

Data Sources, Methods, and Assumptions:

See the document referenced on page G-3 of this Appendix for a more detailed listing of methods, data sources, and assumptions used in this analysis. In summary:

- **Data Sources:** The Arizona Department of Commerce (Jim Westberg, Energy Program Administrator) provided estimates of State building energy consumption. The cost of State building efficiency efforts ($47/MWh) is based on the review of relevant literature summarized in the WGA CDEAC Energy Efficiency Task Force report. The incremental cost of green power ($9/MWh) is based on current bulk programs (such as Pacificorp's BlueSky program).
- **Quantification Methods:** Emissions savings and costs are calculated in a straightforward manner analogous to RCI-1.
- **Key Assumptions:** State building square footage is assumed to grow at the rate of commercial Gross State Product (GSP) growth assumed used in the emission forecast (4.9%/year).

Key Uncertainties:

- Avoided electricity and natural gas costs.
- Costs and availability of efficiency resources.
- Incremental costs of green power.
- Rate of growth in state building area.
- Ability to track and enforce building efficiency and green purchasing goals.

Ancillary Benefits and Costs:

Additional impacts are similar to those described for RCI-1 above.

Feasibility Issues:

None cited.

Status of Group Approval:

Completed.

Level of Group Support:

Unanimous.

Barriers to Consensus:

None cited.

RCI-3 Appliance Standards

Policy Description:

Implementation of State appliance efficiency standards for appliances not covered by federal standards or where higher-than-federal standard efficiency requirements are appropriate.

Policy Design:

Appliance efficiency standards reduce the market cost of energy efficiency improvements by incorporating technological advances into base appliance models, thereby creating economies of scale. Arizona, along with several other states, recently adopted efficiency standards for appliances not covered by federal standards. These state actions ultimately resulted in the adoption of standards for additional appliances in the Energy Policy Act of 2005. Moreover, California has established standards for a number of appliances not currently included in Arizona or national legislation, such as pool pumps, consumer electronics (stand-by power use), and general-service incandescent lamps.

The specific policy approach suggested by the TWG is to:

- First, advocate for stronger federal appliance efficiency standards where this is technically feasible and economically justified.
- Second, for those appliances not likely to be covered by federal efforts, pursue efficiency standards already adopted by California and/or other states[8].
- Where possible, consider encouraging local manufacturing of high-efficiency appliances and equipment when adopting state standards.

Implementation Method(s):

Codes and Standards

Related Policies/Programs in Place:

- Arizona Appliance Efficiency Standards [HB2390]
- Existing Federal Appliance Efficiency Standards [2005 Energy Bill]. These federal standards will effectively build upon and replace the Arizona standards for the same appliance types. However, the impact of these standards (AZ and federal) is not included in the emissions projections included in the State inventory report.[9]

Types(s) of GHG Benefit(s):

Similar to RCI-1.

[8] A CCAG member suggested that the CCAG and TWG also consider including in this option efficiency standards for biomass stoves, solar water heaters, and other renewable energy technologies, as well as for other thermal appliances where efficiency standards do not exist or are inadequate.

[9] The electricity use forecast used in the AZ GHG emissions projections is based on the US Department of Energy's 2005 Annual Energy Outlook, which did not take these standards into account.

Estimated GHG Savings and Costs per tCO_2e:

RCI-3	2010	2020	Units
GHG Emission Savings	0.2	1.0	$MMtCO_2e$
Net Present Value (2006-2020)		-$453	$ million
Cumulative Emissions Reductions (2006-2020)		7	$MMtCO_2e$
Cost-Effectiveness		-$66	$/$tCO_2e$

Recent Actions (HB2390) not included in forecast (GHG Emissions Savings not included above)	2010	2020	Units
Total	0.2	0.8	$MMtCO_2e$

Data Sources, Methods, and Assumptions:

See the document referenced on page G-3 of this Appendix for a more detailed listing of methods, data sources, and assumptions used in this analysis. In summary:

- **Data Sources:** A recent study by the Appliance Standards Assistance Project and the American Council for an Energy Efficiency Economy provides estimates for new standards.[10] The savings from recent actions (previous Arizona efficiency standards) are based on an earlier analysis by the same sources, adapted to the specifications of AZ HB2390.[11]
- **Quantification Methods:** The ASAP/ACEEE report uses estimates of appliance sales by states along standard incremental cost and savings analysis to develop state-specific results for 15 specific appliances.[12] The study's NPV results were derived using the same discount rate (5%) as in our analysis, but a longer time span (to 2030). For consistency, the NPV savings were reduced (by about 30%) to reflect the shorter time horizon used for cost analysis in the CCAG process (to 2020).
- **Key Assumptions**: The ASAP/ACEEE study used prices slightly different than used for the CCAG analyses – they use 9.0c/kWh ($13.52/Mbtu gas) residential and 7.6c/kWh ($9.65/Mbtu gas) commercial. The resulting NPV savings differ slightly from those that would be obtained using our avoided delivered electricity and gas cost estimates[13].

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[10] ASAP and ACEEE, 2006. "Leading the Way: Continued Opportunities for New State Appliance and Equipment Efficiency Standards", http://www.standardsasap.org/stateops.htm.

[11] A TWG member provided a copy of this analysis.

[12] See http://www.standardsasap.org/a062_az.pdf for a table listing the 15 appliances considered, and their costs and savings. The carbon emissions savings shown in this document are not used here; instead the marginal electricity emission factors used for other CCAG policies are used.

[13] The authors of the ASAP/ACEEE study have agreed to re-estimate the cost impacts based on the electricity and gas prices used for the CCAG analysis – updated results to be reported when available.

Key Uncertainties:

- Ability to track and enforce compliance with standards.
- Avoided electricity and natural gas costs.

Ancillary Benefits and Costs:

Similar to RCI-1.

Feasibility Issues:

None cited.

Status of Group Approval:

Completed.

Level of Group Support:

Unanimous.

Barriers to Consensus:

None cited.

RCI-4 Building Standards/Codes for Smart Growth

Policy Description:

Given the State's growth and the long lifetime of buildings, the current and future building codes will have a considerable impact on future energy use in buildings, and on related greenhouse gas emissions. Thus improved and increasingly stringent energy efficiency codes for Arizona are proposed.

Policy Design:

Building energy codes specify minimum energy efficiency requirements for new buildings or for existing buildings undergoing major renovations[14]. It is recommended that Arizona take the following actions in order to realize the energy savings and other benefits offered by state-of-the-art building energy codes[15]:

- Arizona should either establish a statewide mandatory code or strongly encourage local jurisdictions to adopt and maintain state-of-the-art codes. Adoption is targeted for 2007, with codes in force in early 2008, but with the recognition that some municipalities in Arizona may implement energy efficiency codes later than others.
- Arizona and/or local jurisdictions should adopt the 2004 International Energy Conservation Code (IECC), to the extent that adoption has not already occurred. Also, Arizona and/or local jurisdictions should consider adopting innovative features of California's latest Title 24 building energy codes, such as lighting efficiency requirements in new homes. In considering the adoption of building code elements, Arizona and/or local jurisdictions should take into account the time-dependent value of energy by, for example, noting the extra benefits from code revisions that are particularly effective in saving on-peak electricity or gas.
- Arizona and local jurisdictions should update energy codes regularly. A 3-year cycle could be timed to coincide with release of the national model codes.
- Revised building codes for Arizona as a whole and for local jurisdictions should be prepared with the involvement of local chapters of code organizations to assist in obtaining support for and compliance with the new policies. All buildings should be covered, including manufactured homes, and local building inspectors should enforce compliance with codes. Inspectors need to be properly trained in new elements of the codes.

Implementation Method(s):

- Information and education: Would include training and education programs and certification for building planners, builders/contractors, energy managers and

[14] A CCAG member noted that the threshold for major renovation needs to be further defined. This issue should be addressed as this policy is further detailed and as implementation plans are developed.

[15] Many of these suggestions are consistent with recommendations included in the WGA CDEAC EE report (for example, page 59).

operators, local officials, and others in the building industry, including training on building energy performance analysis tools and software. Would also include programs for consumer and elementary/secondary education.

- Training and technical assistance for code enforcement officials, including training and assistance in the use of building energy performance analysis tools and software, and in the review and analysis of the outputs of building energy performance tools.
- Funding mechanisms and or incentives: Utility programs (designed to encourage building energy performance beyond codes) may help to provide financial assistance for training code officials in the application of building energy codes. Increases in permit fees and/or increase in "impact fees" may also be considered to assist with funding of training for code officials.
- Voluntary and or negotiated agreements: Agreements within Metropolitan Area Government councils to collaborate on building energy codes in order to make compliance easier for building contractors and other building trade professionals.
- Codes and standards—In addition to adoption of state and/or local and/or metropolitan area building energy performance codes, Arizona may consider starting a State Building Energy Codes Collaborative process and/or joining a Regional Building Codes Collaborative, as referenced (for example) on pages 65-66 of the WGA CDEAC EE report.

Related Policies/Programs in Place:

Code changes advanced in some localities, beginning in others. Most urban areas have adopted the IECC 2004 codes, and some (notably Tucson) have adopted more stringent codes.

Types(s) of GHG Benefit(s):

- CO_2 reduction from avoided electricity production and avoided on-site fuel combustion.
- Modest reduction in CH_4 emissions from avoided fuel combustion and avoided natural gas pipeline leakage, relatively small reductions in N_2O, Black Carbon emissions from avoided fuel consumption.

Estimated GHG Savings and Costs per tCO_2e:

RCI-4	2010	2020	Units
GHG Emission Savings	0.3	2.2	$MMtCO_2e$
Net Present Value (2006-2020)		-$243	$ million
Cumulative Emissions Reductions (2006-2020)		14	$MMtCO_2e$
Cost-Effectiveness		-$18	$/$tCO_2e$

Recent Actions (Current/planned building code changed) not included in forecast (GHG Emissions Savings not included above)	2010	2020	Units
Total	0.2	0.8	$MMtCO_2e$

Discussion of Results: Savings here are relatively modest in part because significant improvements over codes in place in the last few years are expected as a part of the WGA CDEAC EE Reports "Current Activities" case, and the savings reported here are the different between the "Current Activities" case (used as the basis for the estimate of "Recent Action" impacts shown above) and the more aggressive "Best Practices" case. Savings in emissions related to reduced electricity consumption account for well over 90% of the GHG savings from this policy.

Data Sources, Methods, and Assumptions:

- **Data Sources:** Major data sources include the WGA CDEAC EE report, including background materials for that report developed by the Building Code Assistance Project (BCAP), The Southwest Energy Efficiency Project's (SWEEP) Report Increasing Energy Efficiency in New Buildings in the Southwest: Energy Codes and Best Practices, and results from Table 5.8 of the 2002 Energy Consumptions by Manufacturers--Data Tables published by the US Department of Energy's Energy Information Administration.
- **Quantification Methods:** Results from the WGA CDEAC EE analysis at the State level were adjusted to achieve the results above. See the document referenced on page G-3 of this Appendix for a more detailed listing of methods, data sources, and assumptions used in this analysis.
- **Key Assumptions:** Level of code improvements assumed same as in the WGA CDEAC EE analysis, though parameters are included to allow adjustments of those assumptions. The cost of electricity savings through building code improvements, beyond "baseline values", was assumed to be 4.7 cents/kWh on a levelized basis (same source). Savings in the commercial sector assumes that at least some renovated space is included in code requirements, and that the ratio of renovated space included in energy code requirements to new space included is 0.3. Ratio of gas to electricity savings as in the SWEEP Report, above.

Key Uncertainties:

The degree to which improved codes in Arizona may be similar to those assumed in the WGA CDEAC EE analysis. Results have not yet been adjusted for the degree to which statewide code adoption will be different in different parts of the state, due to varying weather regimes.

Ancillary Benefits and Costs[16]:

- Saving consumers and businesses money on their energy bills
- Potential to also yield water savings
- Comfort/indoor air quality improvements, with related improvements in health and productivity
- Reducing dependence on imported fuel sources, and reducing vulnerability to energy price spikes
- Electricity system benefits: reduced peak demand, reduced capital and operating costs, improved utilization and performance of the electricity system, reduced pollutant emissions from power plants and related public health improvements

[16] Many of these additional benefits are adapted from those listed on page 2 of the WGA CDEAC EE report.

- Supporting local businesses and stimulating economic development
- Low-income populations living in buildings covered by the policy will benefit through lower annual energy costs.

Feasibility Issues:

None cited.

Status of Group Approval:

Completed.

Level of Group Support:

Unanimous.

Barriers to Consensus:

None cited.

RCI-5 “Beyond Code” Building Design Incentives and Programs for Smart Growth

Policy Description:

Building energy performance standards are implemented in State-funded and other (such as local) government buildings, and similar standards are promoted in other buildings, such that new buildings achieve high standards of energy efficiency, and existing buildings are renovated or retrofitted to yield significant energy efficiency improvements.

Policy Design:

Implementation of LEED (Leadership in Energy and Environmental Design, a program of the U.S. Green Building Council) standards/certifications and/or other “green building” certifications and/or measured or modeled building energy performance criteria may be used to specify building energy performance standards.[17] Incorporating white roofs, rooftop gardens (“green roofs,” and shade trees would also be included by this policy. In addition to directly influencing energy use in state-funded and government buildings, this policy will help to raise awareness of energy-efficiency improvement methods in building construction and operation, and will help to “drive” such improvements in other market segments. This policy includes:

- A performance standard for State-owned or State-leased buildings to demonstrate the feasibility of achieving the minimum code requirements as well as exceeding them. This will demonstrate and encourage the use of advanced energy efficiency products and designs, and will also reward the State with the inherent benefits of more efficient buildings. New State-owned or State-leased buildings will be required to use at least 10% less energy per square foot of floor space relative to what the same building would have used if designed to just meet existing energy codes. The requirement of 10% lower energy use will be reviewed periodically, but is expected to remain in force as long as the level of improvement remains cost-effective.
- A requirement that state-owned or leased facilities use life-cycle costing, including full consideration of future energy costs, in the selection and implementation of building designs and components for both new and renovated space, or for the selection of replacement components. Further, following life cycle cost analysis, require that the most cost-effective design/equipment/component options be chosen.
- Provide financial or tax incentive for non-public and non-state public buildings (such as municipal buildings) to improve their energy performance beyond that required by existing codes.[18] Incentives should be provided for building projects (new, renovated,

[17] Note that it is not the intent of this policy that achieving LEED or other certifications be required in order to receive incentives, so long as a project achieves an adequate level of energy savings.

[18] There are, as of the writing of this Policy Description, a number of ongoing discussions regarding the LEED certification program, other certification programs, and potential performance guidelines for new and renovated buildings, and as a result, it is not yet clear which certifications or performance guidelines might be adopted or suggested for use in this program. Whichever set of certifications/performance guidelines are adopted should provide designers, builders and

or remodeled space) where energy consumption per unit floor area is at least 10% less that would be the case if the project met existing codes, noting that energy codes will change over time.[19] Incentives should be structured so that projects that produce higher savings per unit floor area relative to meeting code requirements receive greater incentives.

- Provide similar financial or tax incentives to encourage retrofits of existing buildings to levels of energy efficiency exceeding those required by existing energy codes.
- Performance standards, life cycle costing requirements, and incentive programs to begin at some point to be determined in the future.

Implementation Method(s):

- Information and education: Would include training and education programs and certification for state officials, building planners, builders/contractors, energy managers and operators, and local officials on certification that buildings and building subsystems have met program requirements. Would also include programs for consumer and elementary/secondary education.
- Technical assistance: Assistance to building planners, engineers, and others in energy-efficient design and in building energy efficiency analysis, possibly including reference materials, performance/design guidelines, and assistance with energy performance analysis software.
- Funding mechanisms and or incentives: Tax credits and/or incentives related to the rate of amortization of expenses related to buildings or renovation. State grants to help cover additional costs of energy performance enhancements for municipal government buildings.
- Voluntary and or negotiated agreements: Agreements by municipal governments, builders to meet higher energy performance standards in exchange for special certification and/or financial incentives.
- Codes and standards: For state-owned or state-leased space, requirements to exceed codes in force as noted above.
- Pilots and demos: Applications of building energy performance improvements (possibly including demonstration of construction of buildings to LEED or other relevant standards) and urban landscaping for government buildings.

Related Policies/Programs in Place:

[Note that many of the state programs listed below are either very recently enacted or currently under consideration, and thus may effectively constitute "new" State GHG policies rather than "Business as Usual" (BAU) policies]:

- Related notes in early version of RCI TWG Policy Matrix: "Executive Order 2005-05 implementing renewable energy and energy efficiency in new state buildings; Solar

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contractors with a means to advertise that their work meets a high energy-efficiency standard (through a specific labeling or certification), while also assuring that the actual energy performance of the building significantly exceeds the level required by codes.

[19] A CCAG member noted that even in the absence of a building energy code improvement policy, energy codes will improve over time, and this "baseline" improvement will need to be taken into account in quantifying the benefits and costs of policies to improve building energy efficiency.

Design Standards for State Buildings; Tucson-Pima Sustainable Energy Program; City of Scottsdale Green Building program"

- Notes in early version of RCI TWG Policy Matrix related to professional education/certification: APS and state Energy Office offer building science training; APS subsidizes contractor training; Energy office provides training [in building codes]; • Technical assistance from Rebuild Arizona and Arizona Energy Office [for energy management/building operator training]
- Newly-adopted Federal Energy Credit for houses "that reduce energy use for heating and cooling only (not hot water) by 50% compared to the national model code – the 2004 IECC Supplement", as well as for commercial buildings that "achieve a 50% reduction in annual energy cost to the user, compared to a base building defined by the industry standard ASHRAE/IESNA 90.1-2001"
- Legislation proposed as HB 2858 including a LEED standard for schools, and including methods by which the degree to which schools meet the standard will be monitored.
- Legislation proposed as HB 2430 emphasizing life cycle costing.
- Legislation proposed as HB 2429 for solar tax credits.
- Legislation proposed as HB 2843 for tax credits for high-efficiency residential central air conditioners and ceiling fans (as well as clothes washers).
- Legislation proposed as HB 2324 and recently enacted as ARS 34-451 setting energy efficiency standards for new and existing public buildings.

Types(s) of GHG Benefit(s):

- CO_2 reduction from avoided electricity production and avoided on-site fuel combustion.
- Modest reduction in CH_4 emissions from avoided fuel combustion and avoided natural gas pipeline leakage, relatively small reductions in N_2O, Black Carbon emissions from avoided fuel consumption.

Estimated GHG Savings and Costs per tCO_2e:

RCI-5	2010	2020	Units
GHG Emission Savings	0.2	3.1	$MMtCO_2e$
Net Present Value (2006-2020)		-$59	$ million
Cumulative Emissions Reductions (2006-2020)		18	$MMtCO_2e$
Cost-Effectiveness		-$17	$/$tCO_2e$

Discussion of Results: Commercial sector measures account for over half of total reduction in electricity use (and thus GHG emissions reductions). GHG emissions savings from avoided electricity generation account for over 90 % of total reductions.

Data Sources, Methods, and Assumptions:

- **Data Sources:** Major data sources include the WGA CDEAC EE report, including background materials for that report developed by the Building Code Assistance Project

(BCAP), The Southwest Energy Efficiency Project's (SWEEP) Report Increasing Energy Efficiency in New Buildings in the Southwest: Energy Codes and Best Practices, and results from Table 5.8 of the 2002 Energy Consumptions by Manufacturers--Data Tables published by the US Department of Energy's Energy Information Administration.

- **Quantification Methods:** Quantification starts with an estimate of average electricity use per household and per unit commercial floor space after taking into account changes due to improved energy codes, then applies participation estimates and fractional savings assumptions to estimate potential savings, first in new construction, and then, through application of factors to reflect the participation of other types of buildings (existing, space, renovated space), estimates an overall level of electricity savings. Gas savings are estimated from electricity savings based on SWEEP data (from document above). See the document referenced on page G-3 of this Appendix for a more detailed listing of methods, data sources, and assumptions used in this analysis.
- **Key Assumptions:** Cost of beyond-code improvements assumed to be similar to improvements needed to attain the higher codes included in RCI-4. "Beyond-code" savings assumed to save 15% of household and commercial electricity use (initial assumption).

Key Uncertainties:

Levels of participation and savings achieved by policy in different sectors and markets.

Ancillary Benefits and Costs[20]:

- Potential to also yield water savings, comfort/indoor air quality improvements with related improvements in health and productivity, plus urban design, market transformation, and other benefits.
- White roofs, rooftop gardens, and landscaping, if widely implemented, may have a favorable impact on local climate, for example, reducing nighttime temperatures, potentially allowing a further reduction in energy use for space cooling ("urban heat island" effects).
- Saving consumers and businesses money on their energy bills
- Reducing dependence on imported fuel sources, and reducing vulnerability to energy price spikes
- Electricity system benefits: reduced peak demand, reduced capital and operating costs, improved utilization and performance of the electricity system, reduced pollutant emissions from power plants and related public health improvements
- Supporting local businesses and stimulating economic development
- Low-income populations living in buildings covered by the policy will benefit through lower annual energy costs.

Feasibility Issues:

None cited.

Status of Group Approval:

Completed

[20] Many of these additional benefits are adapted from those listed on page 2 of the WGA CDEAC EE report.

Level of Group Support:

Unanimous

Barriers to Consensus:

None cited.

RCI-6 Distributed Generation/Combined Heat and Power

Policy Description:

Distributed generation with clean combined heat and power systems improves the overall efficiency of fuel use as well as electricity system benefits. Implementation of these systems should be encouraged through a combination of regulatory changes and incentive programs.

Policy Design:

Distributed generation in the form of clean combined heat and power systems give electricity consumers the capability of generating electricity or mechanical power on-site to meet all or part of their own needs, sell power back to the grid, and, through capture of heat typically lost during power generation, meet on-site thermal needs (hot water, steam, space heat, or process heat) or cooling (for example, through application of absorption chillers)[21]. In so doing, distributed generation with combined heat and power (CHP) raises the overall efficiency with which fuel is used. In addition to improvements in the efficiency of fuel use, and related reduction in greenhouse gas emissions, expanded use of distributed CHP offers significant electricity system benefits (including avoided electricity transmission and distribution losses, and avoided requirements for electricity grid expansion). Policies to encourage the adoption of CHP include a combination of regulatory changes and possibly incentives for adoption of CHP systems. CHP systems of 10 MW or smaller (or of equivalent mechanical power) would be covered, and policies in place by the end of 2006, and in force thereafter, with periodic review as needed. The combination of regulatory changes and incentives will be designed to allow a certain percent of Arizona's estimated remaining CHP potential to be realized at some in the future.

Implementation Method(s):

[Note that in the list of incentives below technical assistance, codes and standards, market-based mechanisms, and utility planning (in that order) are considered by TWG members to be of primary importance, while other mechanisms are considered of secondary importance.]

- Information and education: Would include training and education programs and certification for building planners, builders/contractors, energy managers and operators, and state and local officials related to the incorporation of CHP into building plans/designs/operation. Would also include programs for consumer and elementary/secondary education.
- Technical assistance: Assistance in siting and planning CHP systems.
- Funding mechanisms and or incentives: A program similar to that offered in California with up to $500 per kW or equivalent incentives per horsepower (hp) of capacity is possible. Another possible financial incentive is production incentives as included in

[21] The CCAG suggested that this policy option could be expanded to include on-site electricity generation from waste heat.

the proposed legislative bill (HB 2427) of $0.015 per kWh or equivalent incentives per hp-hour.

- Voluntary and or negotiated agreements
- Codes and standards: A national IEEE standard, IEEE #1547, has been adopted to facilitate DG installations. FERC has adopted a national interconnect standard for installation to transmission lines. A number of other states, including Texas, California, New Jersey, and New York, have adopted interconnect standards to facilitate DG installation. A similar standard is needed in Arizona, and has recently been under discussion at the ACC[22].
- Market based mechanisms: Net metering, avoided-cost pricing rules, and/or other utility tariff policies that promote CHP. Performance contracting is another possible mechanism, for example, HB 2430 expands the definition of allowed performance contracting for State facilities and schools to include the use of CHP, and extends the allowable payback period to 25 years (see http://www.azleg.state.az.us/FormatDocument.asp?inDoc=/legtext/47leg/2r/summary/h.hb2430_02-24-06_asengrossedandaspassedhouse.doc.htm).
- Pilots and demos: CHP systems in government buildings.
- Research and development: Support for research on combined power and cooling systems most germane to Arizona
- Utility Planning: Include CHP as an element of resource planning for utilities.

Related Policies/Programs in Place:

Interconnection rules and similar topics are under discussion at the Arizona Corporation Commission (ACC).

Types(s) of GHG Benefit(s):

- CO_2 reduction from avoided electricity production and avoided on-site fuel combustion less additional on-site CO_2 emissions from fuel used in CHP systems.
- Other gases: modest potential changes in emissions of CH_4: from avoided fuel combustion and avoided natural gas pipeline leakage, net of any additional on-site emissions or additional leakage from increased gas use, likely relatively small reductions in emissions of N_2O: from avoided fuel combustion, net of any increased on-site emissions, and also some possible small net changes in emissions of black carbon, depending on the balance between avoided and additional consumption of oil, coal, and biomass fuels, and of emission control equipment used on CHP and heating systems.

[22] Includes in part text provided by the Distributed Energy Association of Arizona.

Estimated GHG Savings and Costs per tCO_2e:

RCI-6	2010	2020	Units
GHG Emission Savings	0.4	2.7	$MMtCO_2e$
Net Present Value (2006-2020)		-$395	$ million
Cumulative Emissions Reductions (2006-2020)		16	$MMtCO_2e$
Cost-Effectiveness		-$25	$/$tCO_2e$

Discussion of Results:

Net emissions reduction as calculated include consideration of avoided central station electricity generation, avoided on-site fuel use (including electricity use) for heating (or cooling) displaced by co generated heat and additional fuel used by CHP systems. Commercial sector measures account for over half of total reduction in electricity use (and thus GHG emissions reductions). Similarly, GHG emissions savings from avoided electricity generation account for over 90% of total reductions.

Data Sources, Methods, and Assumptions:

- **Data Sources:** The Combined Heat and Power White Paper, dated January, 2006, to the Clean and Diversified Energy Initiative of the Western Governors Association; and the 2003 Commercial Buildings Energy Consumption Survey Detailed Tables, published by the US Department of Energy's Energy Information Administration.
- **Quantification Methods:** Starting with an estimate for Arizona's share of CHP potential in the West, as provided in the "CHP White Paper" referenced above, assumptions regarding the penetration of and fuel shares for new CHP systems, estimates of future capacity of CHP developed under the policy are generated. Estimates of CHP cost and performance for different kinds of systems are then used to estimate the overall net GHG emissions reduction and net cost of the policy.
- **Key Assumptions:** Gas-fired systems are assumed to dominate new CHP in Arizona, but some biomass- and coal-fired capacity is also included. Systems are assumed to operate an average of 5000 hours per year (at full capacity), and 90% of co-generated heat is assumed to be usable (and displaces heat from purchased fuels).

See the document referenced on page G-3 of this Appendix for a more detailed listing of methods, data sources, and assumptions used in this analysis.

Key Uncertainties:

Achievable rate of implementation of CHP systems in Arizona, types and amounts of heating fuels that will be displaced, and average future costs of systems.

Ancillary Benefits and Costs[23]:

- Potential increased reliability of electricity supply for CHP hosts, increased flexibility of supply.
- Central-station power plant cooling water savings

[23] Many of these additional benefits are adapted from those listed on page 2 of the WGA CDEAC EE report.

- Potential local air quality impacts (may be positive or negative)
- Saving consumers and businesses money on their energy bills
- Reducing dependence on imported fuel sources, and reducing vulnerability to energy price spikes
- Electricity (grid) system benefits: reduced peak demand, reduced capital and operating costs, improved utilization and performance of the electricity system, reduced pollutant emissions from power plants and related public health improvements
- Supporting local businesses (related to distributed generation/CHP sales, installation, and service) and stimulating economic development

Feasibility Issues:

None cited.

Status of Group Approval:

Completed.

Level of Group Support:

Unanimous.

Barriers to Consensus:

None cited.

RCI-7 Distributed Generation/Renewable Energy Applications

Policy Description:

Distributed generation sited at residences and commercial and industrial facilities, and powered by renewable energy sources, provides electricity system benefits and displaces fossil-fueled generation, thus reducing greenhouse gas emissions. Increasing the use of renewable distributed generation in Arizona can be achieved through a combination of regulatory changes and incentives.

Policy Design:

Customer-sited distributed generation powered by renewable energy sources provides electricity system benefits such as avoided capital investment and avoided transmission and distribution losses, while also displacing fossil-fueled generation and thus reducing greenhouse gas emissions. Customer-sited renewable distributed generation can include solar photovoltaic systems, wind power systems, biogas and landfill gas-fired systems, geothermal generation systems, and systems fueled with biomass wastes or biomass collected or grown as fuel. Policies to encourage and accelerate the implementation of customer-sited renewable distributed generation include direct incentives for system purchase, market incentives–including "net metering"--related to the pricing of electricity output by renewable distributed generation, state goals or directives, and favorable rules for interconnecting renewable generation systems with the electricity grid. Non-electric renewable energy applications also covered by this policy include solar water heat and solar space heat and cooling. It is suggested that Arizona should, at a minimum, set as its target the addition of customer-sited distributed renewable generation consistent with the overall generation capacity by year goals for renewable distributed generation in the West as expressed in the WGA CDEAC reports.

It is expected that implementing agencies will include Public Agencies (systems for state or other government buildings), the Arizona Corporation Commission[24], Arizona State Government, and Utilities.

Implementation Method(s):

- Information and education: Would include training and education programs and certification for building planners, builders/contractors, energy managers and operators, renewable energy contractors, and state and local officials on the incorporation of distributed renewable generation and solar space/water heat in building projects. Would also include programs for consumer and elementary/secondary education.
- Technical assistance: Assistance in siting, designing, planning renewable systems

[24] In addition to the ACC's influence on interconnection and pricing rules that will have a significant impact on the adoption of customer-sited distributed generation, decisions by the ACC on reserving a portion of the Environmental Portfolio Standard to be supplied by customer- sited DG systems will also have an impact on the future implementation of DG renewable energy.

- Funding mechanisms and or incentives: These might include low-interest loan programs, rebates on capital costs, tax incentives, attractive rates for power purchases/net metering, and other incentives.
- Voluntary and or negotiated agreements
- Codes and standards: Common interconnection rules and standards are needed. A national IEEE standard, IEEE #1547, has been adopted to facilitate DG installations. FERC has adopted a national standard interconnect standard for installation to transmission lines. In addition, States, including Texas, California, New Jersey, and New York, have adopted interconnect standards to facilitate DG installation[25].
- Market based mechanisms: Net metering for some renewable distributed generation systems, and possibly avoided-cost pricing rules for others[26].
- Pilots and demos, such as renewable systems in government buildings
- Research and development: Support for development of distributed renewable generation systems most germane to Arizona.
- Regulatory: Complete Environmental Portfolio Standard (EPS) process at the Arizona Corporation Commission, and complete Sustainable Energy process at the Salt River Project.[27]

Related Policies/Programs in Place:

Salt River Project's Solarwise program; TEP and UES Sunshare PV buydowns; Arizona's state Solar and Wind Equipment Sales Tax Exemption; and existing Solar and Wind Energy Systems Tax Credits.

Types(s) of GHG Benefit(s):

- CO_2 reduction from avoided fossil-fueled electricity production.
- Modest reduction in emissions of CH_4 from avoided fuel combustion in electricity generation and avoided natural gas pipeline leakage. Likely small reductions in N_2O and Black Carbon emissions from avoided fuel combustion in electricity generation.

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[25] Includes in part text provided by the Distributed Energy Association of Arizona.

[26] TWG members identified the need to coordinate with and support the ongoing ACC process on net metering as an important means toward achieving substantial use of distributed generation in Arizona. HB 2427 entitled "Tax Credit; Renewable Energy" creates new state income tax credits of 1.5 cents per kWh of electricity generation (and 1.1 cents per hp-hr of mechanical energy produced), beginning in 2007, for individual or corporate taxpayers who produce and sell power from "qualified energy resources", including solar, wind, closed-loop biomass, geothermal, small irrigation power, and combined heat and power. See http://www.azleg.state.az.us/FormatDocument.asp?inDoc=/legtext/47leg/2r/summary/h.hb2427_02-21-06_caucuscow.doc.htm

[27] Includes in part text provided by the Distributed Energy Association of Arizona.

Estimated GHG Savings and Costs per tCO_2e:

RCI-7	2010	2020	Units
GHG Emission Savings	0.1	2.1	$MMtCO_2e$
Net Present Value (2006-2020)		$293	$ million
Cumulative Emissions Reductions (2006-2020)		10	$MMtCO_2e$
Cost-Effectiveness		$31	$/$tCO_2e$

Discussion of Results: Net emissions reductions as calculated include consideration of avoided central station electricity generation, less modest net GHG emissions from additional fuel use (biomass, biogas, and landfill gas). Most of the costs and savings from this policy are from installation of solar PV systems; under current assumptions, a cumulative 850 MW of Solar PV are installed through 2020.

Data Sources, Methods, and Assumptions:

- **Data Sources:** Arizona "State Fact Sheet" from the Southwest Energy Efficiency Project's Report Increasing Energy Efficiency in New Buildings in the Southwest: Energy Codes and Best Practices; USDOE/EIA document 2003 Commercial Buildings Energy Consumption Survey Detailed Tables; Worksheet "Solar Homes Summary table.xls", with calculations in support of the California Million Solar Homes Initiative, authored by XENERGY, Inc., and provided by M. Lazarus; Arizona Consumer's Guide to Buying a Solar Electric System, from the Arizona Solar Center; sources with information on Photovoltaic costs.
- **Quantification Methods:** Projection of the number of new and existing homes, and new and existing commercial floor space, in Arizona through 2020 were coupled with an initial estimate for the penetration of solar PV panels and estimates of solar PV current and future costs to yield estimates of solar PV capacity and performance by year.
- **Key Assumptions:** Rates of growth of housing and commercial floor space; addition of residential and commercial PV systems at a penetration rate roughly consistent with that assumed for the "Million Solar Homes" initiative in California; annual solar capital cost reductions of about 5%, and addition of a total of 10 MW of new customer-sited biomass/landfill gas/biogas-fueled capacity per year by 2020.

See the document referenced on page G-3 of this Appendix for a more detailed listing of methods, data sources, and assumptions used in this analysis.

Key Uncertainties:

Future solar PV costs, solar PV penetration rates.

Ancillary Benefits and Costs[28]:

- Increased flexibility of electricity supply for consumers hosting generation.
- Central-station power plant cooling water savings

[28] Some of these additional benefits are adapted from those listed on page 2 of the WGA CDEAC Energy Efficiency Task Force report.

- Potential local air quality impacts (may be positive or negative, depending on technology)
- Saving consumers and businesses money on their energy bills (and/or offering a new income stream)
- Reducing dependence on imported fuel sources, and reducing vulnerability to energy price spikes
- Where waste biomass fuels are used, possible reduction in disposal cost, reduction in environmental impacts related to disposal
- Electricity (grid) system benefits: reduced peak demand, reduced capital and operating costs, improved utilization and performance of the electricity system, reduced pollutant emissions from power plants and related health improvements
- Supporting local businesses (related to renewable system sales, installation, and service, and possibly biomass fuel supply) and stimulating economic development.

Feasibility Issues:

None cited.

Status of Group Approval:

Completed.

Level of Group Support:

Unanimous.

Barriers to Consensus:

None cited.

RCI-8 Electricity Pricing Strategies

Policy Description:

Adjustments in electricity pricing to reflect the true time-dependent cost and value of generation are suggested as means to both lower the overall costs and emissions from electricity system operation and to encourage the implementation of clean customer-sited combined heat and power and distributed generation.

Policy Design:

As with other energy and non-energy commodities, the pricing of electricity—including electricity from the grid used by consumers and electricity generated on the consumers' premises flowing to the grid—can have a significant impact on consumers' usage decisions. Proper and clear electricity tariffs and price signals can provide significant encouragement to distributed generation, energy conservation (in many forms), and reduction of electricity use during times of peak electricity demand. Creating such tariff structures may involve restructuring tariffs to provide incentives for "shoulder[29]" and peak demand reduction—for example, through implementation of time-of-use energy charges—as well as setting net metering or other rules for sales from distributed generation to the grid that provide appropriate credit for the electricity generated during periods of high power demand[30]. Changes in tariff structures are also needed that revise the balance between energy and demand charges and change the way that demand charges are fixed. These changes should be designed so as to provide improved incentives for end-users to adjust the timing of energy use so as to reduce greenhouse gas emissions as much as possible. The initiation of inverted block rates, where higher tariffs are charged once electricity use per household (for example) reaches a threshold level each month, is also recommended.

These tariff and pricing changes should be implemented by a set date in the future so as to remove barriers to and create incentives for customer-sited CHP and renewable generation as soon as possible. Note that it will likely not be possible to isolate the impacts of these tariff and pricing changes from policies such as RCI-1, RCI-2, RCI-6, and RCI-7, and as such the costs and impacts of these tariff and pricing policies will likely be taken into account in the quantification of costs and impacts other RCI policies (which RCI-8 policies support). To avoid double counting, then, the costs and impacts of tariff and pricing changes (with the exception of inverted block rates) will not be quantified separately[31].

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[29] "Shoulder" periods of electricity demand occur in the periods before and after the period of daily system peak power demand.

[30] A CCAG member noted that tariff changes that result in a shift in demand will not necessarily result in a reduction of carbon emissions from electricity generation, as emissions changes will depend on which generation units are affected by shifts in load.

[31] A CCAG member suggested that those pricing strategies that result in a net reduction in electricity consumption might result in quantifiable savings, and suggested that "moderate importance" be placed on further investigating such strategies, and that the topic be addressed in the next RCI TWG meeting. The impacts of these strategies were subsequently quantified, as noted below.

Implementation Method(s):

Note that in the list of incentives below, rate designs, codes and standards, market-based mechanisms, and funding mechanisms and/or incentives (in that order) are considered by the TWG to be of primary importance, while other mechanisms are considered of secondary importance.

- Information and education: Would include programs for consumer education, information for distributed generation hosts.
- Technical assistance: Assistance to consumers/potential distributed generation hosts in economic analysis of potential systems
- Funding mechanisms and or incentives: Pricing incentives/TOU pricing
- Codes and standards: Common interconnection rules and standards are needed. A national IEEE standard, IEEE #1547, has been adopted to facilitate DG installations. FERC has adopted a national interconnect standard for installation to transmission lines. In addition, several States, including Texas, California, New Jersey, and New York, have adopted interconnect standards to facilitate DG installation[32].
- Market based mechanisms: Net metering for some renewable distributed generation/CHP systems, avoided-cost pricing rules for others, TOU tariffs. Inverted block rates to spur conservation of electricity use by households using above-average quantities of electricity.
- Pilots and demos: Pilot TOU rate implementation, and pilot renewable and CHP systems in government buildings, with tracking of costs/income
- Research and development: Support for development of electricity pricing systems
- Rate Designs: Incorporate new rate designs in current DG Workshops and upcoming APS rate case. Legislative action may be needed requiring new Salt River Project standards be implemented.

Related Policies/Programs in Place:

APS Commercial Peak Reduction Campaign

Types(s) of GHG Benefit(s):

Policy contributes to:

- CO_2 reduction from avoided electricity production and avoided on-site fuel combustion less additional on-site CO_2 emissions from fuel used in CHP systems.
- Other gases: modest potential changes in emissions of CH_4: from avoided fuel combustion and avoided natural gas pipeline leakage, net of any additional on-site emissions or additional leakage from increased gas use, likely relatively small reductions in emissions of N_2O: from avoided fuel combustion, net of any increased on-site emissions, and also some possible small net changes in emissions of black carbon, depending on the balance between avoided and additional consumption of oil, coal, and biomass fuels, and of emission control equipment used on CHP and heating systems.

[32] Portions of this description were adapted from text provided by the Distributed Energy Association of Arizona through TWG member Penny Allee Taylor.

Estimated GHG Savings and Costs per tCO_2e (quantified for inverted block rates only):

RCI-8	2010	2020	Units
GHG Emission Savings	1.1	1.5	$MMtCO_2e$
Net Present Value (2006-2020)		-$985	$ million
Cumulative Emissions Reductions (2006-2020)		16	$MMtCO_2e$
Cost-Effectiveness		-$63	$/$tCO_2e$

Data Sources, Methods, and Assumptions:

- **Data Sources:** For impacts of inverted block rate and similar tariff structures, the SWEEP "New Mother Lode" study provides one of the few available estimates, and is thus used here. Studies of similar programs in Utah and elsewhere may be used in the future to estimate the impacts of the inverted block rate element of this policy.
- **Quantification Methods**: Note that it will likely not be possible to isolate the impacts of these tariff and pricing changes from policies such as RCI-1, RCI-2, RCI-6, and RCI-7, and as such the costs and impacts of these tariff and pricing policies will likely be taken into account in the quantification of costs and impacts other RCI policies (which RCI-8 policies support). The net impacts of TOU rates may be positive or negative, but probably should be assessed as a part of other policies. To avoid double counting, then, the costs and impacts of tariff and pricing changes will likely not be quantified separately. Inverted block tariff structures, which may yield significant overall demand reduction, are quantified based on the estimated monthly savings from implementation of an aggressive, but revenue-neutral, tariff structure.
- **Key Assumptions:** Impact of suggested policies on uptake of consumer -sited CHP and renewable generation in Arizona; impact of TOU rates on utility load curves.

Key Uncertainties:

None cited.

Ancillary Benefits and Costs[33]:

- Increased flexibility of electricity supply for consumers hosting generation.
- Central-station power plant cooling water savings
- Potential local air quality impacts (may be positive or negative, depending on technology)
- For pricing that induces new distributed generation, saving consumers and businesses money on their energy bills (and/or offering a new income stream)
- Some pricing structures may have negative impacts on low-income consumers—need to adopt rate designs or mitigating programs to address such impacts as a part of implementation strategies.

[33] Some of these additional benefits are adapted from those listed on page 2 of the WGA CDEAC Energy Efficiency Task Force report.

- Reducing dependence on imported fuel sources, and reducing vulnerability to energy price spikes
- Where waste biomass fuels are used, possible reduction in disposal cost, reduction in environmental impacts related to disposal
- Electricity (grid) system benefits: reduced peak demand, reduced capital and operating costs, improved utilization and performance of the electricity system, reduced pollutant emissions from power plants and related health improvements
- Supporting local businesses (related to renewable system sales, installation, and service, and possibly biomass fuel supply) and stimulating economic development

Feasibility Issues, if applicable:

None cited.

Status of Group Approval:

Completed.

Level of Group Support:

Unanimous.

Barriers to Consensus:

None cited.

RCI-9 Mitigating High Global Warming Potential (GWP) Gas Emissions (HFC, PFC)

Policy Description:

A combination of voluntary agreements with industries and of new specifications for key equipment is suggested to reduce the emissions of process gases that have high global warming potential.

Policy Design:

Based on a review of available options to further reduce high-GWP gas emissions in the RCI sectors, the TWG suggests further consideration of specifications for new commercial refrigeration equipment.[34] Such specifications and possible voluntary incentives—now under consideration and analysis by the California Air Resources Board—would: a) promote the use of low GWP refrigerants[35] in refrigerators in retail food stores, restaurants, and refrigerated transport vehicles (trucks and railcars); and/or b) require or provide incentives that centralized systems with large refrigerant charges and long distribution lines be avoided in favor of systems that use much less refrigerant and lack long distribution lines.[36] It is specifically recommended that the Governor explore working with California and other states in addressing HFC emissions from refrigeration.

While a focus on commercial refrigeration emerged from TWG discussions, participants also noted that maintaining momentum of voluntary industry-government partnerships (such as the semi-conductor industry agreement) should be a high priority.

Implementation Method(s):

These could consist of hybrid approach, combining market-based incentives and codes and standards (specifications).

Related Policies/Programs in Place:

- The Intel voluntary agreement noted above is producing significant reductions in PFC emissions from semiconductor manufacturing. Intel estimates that, in their Arizona

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[34] Based on the current AZ emissions inventory and projection, GHG emissions from hydrofluorocarbons (HFCs) could grow from about 1 MMtCO$_2$e or <1% of Arizona GHG emissions in 2000 to over 7 MMtCO$_2$e or about 5% of state emissions by 2020. Most HFC emissions are expected to result from leaks in mobile air conditioning and refrigeration applications. Other sources of high Global Warming Potential (GWP) gases, which include the emission of perfluorocarbons (PFCs) and HFCs and from semiconductor manufacture and leakage of sulfur hexafluoride (SF_6) from electricity distribution equipment, contribute less to state emissions, and these emissions are expected to decline based on existing emission reduction efforts, such as the semiconductor industry's voluntary worldwide agreement.

[35] Examples include lower GWP HFCs, carbon dioxide, and hydrocarbons (propane or isobutene/propane blend).

[36] A CCAG member suggested following up in additional detail the specifications for using substitute for high-GWP gases now being discussed or in place in California, and which might be considered for Arizona. Another CCAG member noted that there are existing data on reduction of PFC use in the electronics industry that should be reviewed by the TWG. Also mentioned by the CCAG was the desire to consider progress in the reduction of SF_6 use in the electric utility sector.

operations, PFC emissions will be reduced 0.22 $MMtCO_2e$ below 2000 levels by 2010. This estimate is reflected below.[37]

Types(s) of GHG Benefit(s): This policy option would directly reduce HFC emissions. There is a possible rebound effect if substitute refrigerants are used and are less energy-efficient, which might increase CO_2 emissions from electricity production.

Estimated GHG Savings and Costs per tCO_2e:

Recent Actions (GHG Emissions Savings from semi-conductor industry voluntary agreement)	2010	2020	Units
Total	0.22	0.22	$MMtCO_2e$

Key Uncertainties:

None cited.

Ancillary Benefits and Costs:

None cited.

Feasibility Issues:

None cited.

Status of Group Approval:

Completed.

Level of Group Support:

Unanimous.

Barriers to Consensus:

None cited.

[37] The state inventory and forecast for PFC emissions is based on the national USEPA projections, which assume a significant drop in emissions by 2010 and 2020 due to the industry voluntary agreement. Therefore these reductions are likely already included in the forecast; they are reported here for transparency and future reference.

RCI-10 Demand-Side Fuel Switching

Policy Description:

Reductions in greenhouse gas emissions can be achieved in the residential, commercial and industrial end-use sectors when consumers switch to the use of less carbon-intensive fuels to provide key energy services.

Policy Design:

Fuel switching opportunities can include using natural gas in the place of electricity for thermal end-uses, natural gas in the place of coal for key industrial end-uses, biomass fuels in the place of electricity or natural gas for thermal end-uses, and solar thermal energy in the place of electricity or natural gas for thermal end-uses.

The three following options are proposed:

- Phase I: Promotion of switching from high-carbon fuels to lower-carbon fuels (such as from oil or coal to natural gas).
- Phase II: Promotion of "low or zero carbon" fuels via incentives.[38]
    - The promotion of solar water heating through a combination of incentives and targeted research. These would build on incentives that already exist in the State.
    - The substitution of biodiesel for diesel in commercial and industrial equipment. Inventory estimates suggest that diesel/distillate fuel use in commercial and industrial sectors comprised 2-3% of the state's emissions in 2003 (2.3 million MM_TCO_{2e}), thus the potential for emissions reductions could be quite significant.

Goals: Given the limited amount of coal use in the RCI sectors Arizona, and the site-specific issues (e.g. in cement production), goals for, and analysis of, switching among fossil fuels (Phase I) have not yet been developed. For the Phase II options, in order to develop a rough quantification, the CCS team used some simple placeholders for the biofuels and solar water heating options. These should not be viewed as specific recommendations, but rather a way to gauge emissions impacts and to kick-start further discussions.

- **Biofuels.** There are at least two possible approaches here: a) biofuels are blended and supplied statewide as the standard filling station fuel (engine modifications unlikely to be required); b) pure biofuels (such as 100% biodiesel) are purchased directly by consumers and used in engines or other applications with technical modifications, if and as needed. To get an order of magnitude estimate of potential

[38] CCAG members have noted the importance of considering the cost of fuel-switching alternatives on a cost per ton of carbon savings basis, as well as the need to consider incentive structures that allow the users of alternate-fuel systems to pay back incentives over time so as to reduce the cost burden on society as a whole. CCAG members also noted that there could be a tradeoff between new incentives provided for the use of low/no-carbon fuels and current incentives effectively in place for fossil fuels, as well as tradeoffs between the costs of action to reduce greenhouse gas emissions and the costs of inaction.

savings, we estimated emissions savings for a scenario in which biodiesel displaces 2% of diesel use by 2010 and rising to 20% by 2020.

- **Solar Water Heat.** For illustrative purposes we assume that solar water heaters could provide 70% of the energy needed in 5% of water heating applications (residential/commercial) by 2010, and in 25% of applications by 2020.

Implementation Method(s):

The following mechanisms could be implicated.

- Further tax or other financial incentives for solar water heating systems (see BAU policies).
- Targeted research at Arizona universities and research institutions to develop new and more cost-effective solar water heating technologies.
- Policies to promote the uptake of biofuels in commercial and industrial applications (See Transportation TWG)

Related Policies/Programs in Place:

- Arizona's Solar Energy Credit provides an individual taxpayer with a credit for installing a solar or wind energy device at the taxpayer's Arizona residence. The credit is allowed against the taxpayer's personal income tax in the amount of 25% of the cost of a solar or wind energy device, with a $1,000 maximum allowable limit, regardless of the number of energy devices installed.
- Arizona provides a sales tax exemption for the sale or installation of "solar energy devices". A solar energy retailer may exclude from tax up to $5,000 from the sale of each solar energy device, and a solar energy contractor may exclude up to $5,000 of income derived from a contract to provide and install a solar energy device.

Types(s) of GHG Benefit(s):

Solar water heating will avoid CO_2 emissions from displaced fuel use (e.g. gas) or electricity generation. Biofuels will avoid CO_2 emissions from diesel and gasoline combustion; however, lifecycle emissions from the production of biofuels need to be considered, and these could involve N_2O emissions from crop production. Other emissions impacts are likely to be relatively insignificant.

Estimated Illustrative GHG Savings and Costs per tCO_2e:

RCI-10	2010	2020	Units
GHG Emission Savings	0.1	1.2	$MMtCO_2e$
Net Present Value (2006-2020)		$0	$ million
Cumulative Emissions Reductions (2006-2020)		7	$MMtCO_2e$
Cost-Effectiveness		Not Estimated	$/$tCO_2e$

Other Key Results (RCI-10)	2010	2020	Units
GHG Emission Savings from Solar Water Heating	0.09	0.71	$MMtCO_2e$
GHG Emission Savings from Biodiesel	0.04	0.47	$MMtCO_2e$

Discussion: This analysis reflects a very rough estimate of impacts as noted above. As a result, costs are not estimated.

Data Sources, Methods, and Assumptions:

See the document referenced on page G-3 of this Appendix for a more detailed listing of methods, data sources, and assumptions used in this analysis. In summary:

- **Data Sources:** Key data sources include Argonne National Laboratory (life cycle biofuel CO_2e emissions), Lawrence Berkeley Laboratory and Public Service of New Mexico (to estimate electricity and gas used for water heating – no AZ data sources were found).
- **Quantification Methods:** The estimated emissions reductions are calculated in a straightforward manner based on multiplication of the various factors and assumptions noted here.
- **Key Assumptions:** See under "goals" above. It is assumed that most ethanol is provided from corn, and that by 2020, 20% of ethanol would be provided by cellulosic sources. Biodiesel is assumed to reduce the life-cycle GHG emissions of diesel by 78% on a tCO_2e/Btu basis.

Key Uncertainties:

None cited.

Ancillary Benefits and Costs:

- Potential local air pollution impacts (from switching from electricity to on-site fuels combustion, or from gas to other fuels)
- Potential local and state economic co-benefits [including rural employment] from using local biomass fuel supplies and installation of solar water heating systems.
- Biomass fuel supply/use may interact with land use, forestry, local air quality issues (from notes in the RCI TWG Policy Matrix).

Feasibility Issues:

None cited.

Status of Group Approval:

Completed.

Level of Group Support:

Unanimous.

Barriers to Consensus:

None cited.

RCI-11 Industrial Sector GHG Emissions Trading or Commitments

Note: This Option Is Moved to ES-4. During the May 16, 2006, CCAG meeting, it was agreed that further consideration of this option would be as part of Energy Supply option ES-4 (Cap and Trade Program). In Arizona, GHG emissions from power plants are likely to be over 10 times higher than emissions from industrial sources large enough to likely be included in a cap and trade program. Given that a common cap and trade program would likely apply to all sources (industrial and power supply), it was felt that the common discussions should occur within the ES group (with RCI participation).

Policy Description:

Industrial sector GHG emissions trading systems, with mandatory "caps" or voluntary emissions, are a means of limiting overall emissions while providing firms with choices as to how emissions limits will be achieved.

Policy Design:

Emissions cap and trade programs and/or voluntary emissions targets are options that have been considered for systematically addressing industrial sector GHG emissions. For example, a number of large industries (such as steel and cement) are included within the European emissions trading system, and have been proposed for inclusion in national legislation. Voluntary commitments have also been adopted within the US and internationally, exemplified by the US Climate Leaders program. This policy option specifically addresses how industrial sector sources would be addressed by trading systems and/or voluntary commitments.

The TWG suggests that an important first step would be to encourage the adoption of procedures to assist in the development of organizational GHG inventories, as would be enabled by a GHG registry.

RCI TWG members believe that emissions trading[39], in general, is a good idea. TWG members feel that a regional or national program approach would be preferable to a state level one. They feel that because the CCAG is a state-level advisory group, it may exceed the mandate of the CCAG to attempt development of a straw proposal; rather, an institution at a regional level or national level would best develop the concept and design elements. A recommendation for the CCAG to consider is a request that the governor explore a regional emissions trading program in a regional forum and/or advocate for development of national program.

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[39] Some TWG members feel that reference to emissions trading should explicitly include consideration of an emissions cap. There was not full TWG consensus on this matter. Some CCAG members also felt that a cap on emissions, possibly even at the State level, should be considered, perhaps in a phased manner, with a (combined RCI and ES) cap system put in place first for utilities, with industrial sector emitters covered by the program in a later phase, although another CCAG member suggested that if industries make significant progress in reducing emissions on their own, a cap for industries may not be needed.

RCI-12 Solid Waste Management

Policy Description:

This policy option considers several options to increase recycling and reduce waste generation in order to limit greenhouse gas emissions associated with landfill methane generation and with the production of raw materials.

Policy Design:

In 2005, over 3 million residents in 39 Arizona communities had access to residential curbside recycling, representing slightly over 50% of the state's population. To further increase the diversion of waste from landfill and the amount of materials recycled, the State should aim to:

- Ensure that curbside recycling programs are provided in all communities over 50,000 in population;
- Increase the penetration of recycling programs in multi-family dwellings;
- Create new recycling programs for the commercial sector;
- Provide incentives for the recycling of construction materials;
- Develop markets for recycled materials;
- Increase average statewide participation/recovery rates for all existing recycling programs; and,
- Develop a statewide recycling goal.

Implementation Method(s):

Implementation options that should be considered include:

- **Expansion of ADEQ Waste Reduction Assistance (WRA) grants**. Grants can target projects that include new or expanded curbside recycling programs. Grants for new and expanded recycling programs to help overcome initial cost barriers faced by communities;[40]
- **Mandatory source separation and recycling laws or ordinances in urban areas.** Municipalities in several states require households or businesses to use recycling containers or services for targeted materials (e.g. office paper, home recyclables).[41] Some AZ solid waste experts feel that such measures may be needed if participation rates are to be increased, and suggest starting with banning of landfill disposal of consumer electronics (a toxics hazard) to evaluate feasibility;

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[40] In 2006, four of the six awards were to communities for such projects.

[41] For instance, participants using standard waste containers for targeted items may be issued warning notices and/or fines for non-compliance.

- **Tax breaks or other incentives** to make recycling financially attractive for private commercial sector waste haulers;
- **Full recycling as a contract requirement for state facilities**;
- **Government purchasing requirements for recycled content** of items purchased (paper, carpets, etc.);
- **Waste education campaign**, aiming at waste reuse and reduction, and targeting greenhouse gas reductions; and,
- **General awareness building**, e.g., working with community leaders to appreciate benefits and cost-effectiveness of curbside recycling.

Related Policies/Programs in Place:

See above.

Types(s) of GHG Benefit(s):

Waste prevention and recycling (including composting) divert organic wastes from landfills, thereby reducing the methane released when these materials decompose. Manufacturing goods from recycled materials typically requires less energy than producing goods from virgin materials. Waste reduction and reuse means less energy is needed to extract, transport, and process raw materials and to manufacture products.[42]

Estimated GHG Savings and Costs per tCO_2e (for quantified actions):

RCI-12	2010	2020	Units
GHG Emission Savings	2.2	3.7	$MMtCO_2e$
Net Present Value (2006-2020)		$0	$ million
Cumulative Emissions Reductions (2006-2020)		36	$MMtCO_2e$
Cost-Effectiveness		Not Estimated	$/$tCO_2e$

Note that about 15% of the above savings is estimated to be from avoided emissions from land filling (largely avoided methane release), and these savings should occur within the state. The other 85% is associated with avoided emissions related to the lower life cycle emissions of recycled compared with virgin products (wood harvesting, pulp and paper processing, transportation). To the extent that paper is manufactured outside the state, these emissions reductions will also occur outside the state.

Data Sources, Methods, and Assumptions:

- **Data Sources:** Key data sources include ADEQ (recycling amounts), USEPA studies (results from studies of life-cycle GHG emissions associated with managing waste materials)
- **Quantification Methods:** Assumes above efforts can increase amount of paper recycled by 600,000 short tons by 2010 and 1,000,000 short tons by 2020. Benefits from increased recovery of other materials not yet considered.

[42] Adapted from USEPA. See website for further details: http://yosemite.epa.gov/OAR/globalwarming.nsf/content/ActionsWasteBasicInfoGeneral.html

- **Key Assumptions:** Assumes national average landfill practices (methane recovery), transport distances, and waste composition (in a given category).

Key Uncertainties:

Key uncertainties are related to the feasibility and impact of the above recommendations.

Ancillary Benefits and Costs:

These could include:

- Reduction in environmental impacts related to disposal of wastes that are recycled and/or composted
- Income from sales of recycled materials, savings from avoided cost of landfill tipping fees
- Reduction of impacts related to manufacturing of new materials through recycling
- Local economic benefits from businesses engaged in recycling or reuse-related activities

Feasibility Issues:

None cited.

Status of Group Approval:

Completed.

Level of Group Support:

Unanimous.

Barriers to Consensus:

None cited.

RCI-13 Water Use and Wastewater Management

Policy Description:

A considerable amount of energy is used to pump, treat, and deliver water across the state. This policy options aims to reduce energy consumption by reducing overall water use and improving the efficiency of water supply and wastewater facilities.

Policy Design:

The State currently uses about 7.7 million acre-feet (MAF) of water, 77% of which is delivered to agricultural consumers, 18% to municipal consumers, and the remainder to industrial users. A significant amount of energy is used to pump this water from underground aquifers (3.6 MAF), from the Colorado River (2.6 MAF), and other sources (1.2 MAF), and to treat it in wastewater facilities after it is used.[43] Five specific recommendations are provided below:

1. Accelerate investment in water use efficiency: Implement best management practices and efficient water management practices, and provide incentives for implementation of water management improvement measures. Coordinate with the investments in energy efficiency (RCI-1). Start in the areas of the state with most energy-intensive water use cycles. Consider developing a statewide water and wastewater savings plan, based on a thorough assessment of water and wastewater options in all water using sectors.

2. Increase the energy efficiency of all water and wastewater treatment operations. Develop long-term programs to better mesh with the long-term investments in water and wastewater infrastructure. For example, for water pumping, in particular, two specific options are worth considering:[44]

   - Pump Testing Program. A large amount of energy is likely expended by a small number of older well pumps that are often run until they failure, many years after it would be economic to replace them. Incentives combined with the provision of energy efficiency information through the existing DWR pump testing program could lead to significant energy savings.

   - Encouraging Pump Design/Planning/Maintenance Best Practices Study in Rapidly Growing Areas. Many municipalities, especially small but rapidly growing cities, lack the experience or resources to optimize the specifications of new pumps to reduce energy consumption. An effort to benchmark effective pump specification, management, and maintenance procedures across municipalities and to share best practices with emerging cities could yield large savings.

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[43] Other sources include the Salt and Gila Rivers. For a good description of the state's water sources and uses, see http://www.tceq.state.tx.us/assets/public/compliance/R15_Harlingen/US-MX%20BGC%20Water%20table%20documents/US%20States/Arizona/bgc_resources_and_issues_presentation_final.ppt.

[44] Thanks go to Chico Hunter of SRP for valuable inputs on this option.

3. Increase energy production by water and wastewater agencies from renewable sources such as in-conduit hydropower and biogas. Add generation from solar and wind resources to water and wastewater projects where applicable.
4. Encourage and create incentives for technologies with the capability to reduce water use associated with power generation. Included would-be zero- or low-water-use technologies and renewable energy technologies, as well as energy efficiency technologies that reduce electricity consumption.
5. Ensure that power plants use the best management practices and economically feasible technology available to conserve water (via siting, evaluation, permitting or other processes).

Implementation Method(s):

Specific implementation strategies are to be determined.

Related Policies/Programs in Place:

The AZ Department of Water Resources maintains a number of water management programs and policies.[45]

Types(s) of GHG Benefit(s):

GHG benefits (primarily CO_2) would result from avoided fuel and electricity consumption for pumping, treating, and delivering water.

Estimated Illustrative GHG Savings and Costs per tCO_2e:

RCI-13	2010	2020	Units
GHG Emission Savings	0.2	0.8	$MMtCO_2e$
Net Present Value (2006-2020)		$0	$ million
Cumulative Emissions Reductions (2006-2020)		6	$MMtCO_2e$
Cost-Effectiveness		Not Estimated	$/$tCO_2e$

This analysis illustrates very roughly the magnitude of GHG savings that might result if state water use could be reduced by 10% compared with current usage levels by 2020 (i.e. by 0.8 MAF). Note that improvements in pump efficiency would provide GHG savings over and above this level; however, pump efficiency improvement potentials may already be partly taken into account in RCI-1 (for electric pumps only).

Data Sources, Methods, and Assumptions:

See the document referenced on page G-3 of this Appendix for a more detailed listing of methods, data sources, and assumptions used in this analysis. Sufficient information for cost-effectiveness assessment is not available. In summary:

- **Data Sources:** Arizona Department of Water Resources (water use levels) and California State Agencies (energy use and GHG emissions related to water use).

[45] See, for example, http://www.tceq.state.tx.us/assets/public/compliance/R15_Harlingen/US-MX%20BGC%20Water%20table%20documents/US%20States/Arizona/bcgwater_admin_overview.doc.

- **Quantification Methods:** The above estimate assumes a 10% water savings (relative to current levels) is achieved by 2020 (3% by 2010), and that 1 $MtCO_2e$ could be avoided for each MAF saved (based on CA estimates).
- **Key Assumptions:** The key assumption is that a 10% water savings is achievable by 2020.

Key Uncertainties:

Key uncertainties are related to the feasibility and impact of the above recommendations.

Ancillary Benefits and Costs:

These could include:

- The ancillary benefits and costs described for other energy efficiency options (see RCI-1)
- Reduced cost of electricity for water pumping displaced fuels costs for users of landfill gas and captured gas from waste treatment facilities.
- Central-station power plant cooling water savings
- Reducing dependence on imported fuel sources, and reducing vulnerability to energy price spikes

Feasibility Issues:

None cited.

Status of Group Approval:

Completed

Level of Group Support:

Unanimous

Barriers to Consensus:

None cited.

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